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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Pipe Connector.

I, PIERRE DESILLES, a citizen of the French Republic, of 28, Rue de Suresnes, Nanterre (Seine), France, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a new device for providing a leak-tight coupling for tubes or pipes which are intended to be connected to a coupling sleeve, terminal nozzle or like component (which will be designated hereinafter as the "nipple") by virtue of a partially deformable ring which is clamped against said sleeve or the like by means of an external nut which is screwed on this latter.

The connectors of this type, that is to say those which make use at the present time of deformable insetting rings are well known and favoured by the majority of industrial users.

Such connectors are frequently employed for the installation of high-pressure conduits which set stringent conditions both as regards the need to avoid any error or fault in assembly and as regards the need to ensure perfect service and leak-tightness.

However, the devices in existence up to the present time have not proved satisfactory from all points of view and in all cases especially insofar as concerns ease of assembly and disassembly, uniformity of deformations of certain portions of the ring and the degree of control exercised by the operator over the proper execution of the coupling operation.

The present invention proposes to provide an improved connector which offers substantial advantages, and especially the following: ease of assembly and disassembly, the guarantee that no error is liable to occur in the direction of presentation of the sealing ring on the tube, the possibility of insetting the sealing ring on the tube in advance, or preinsetting, the clear perception by the operator of the completion of the insetting operation at the time of tightening of the connector nut, and the control of leak-tightness.

The sealing-ring connector in accordance with the present invention comprises in known manner a deformable ring provided internally with a sharp edge which is adapted to penetrate in the external surface of the tube to be connected as a result of screwing of the clamping nut which is provided for this purpose with an internal conical portion; and said connector is further characterized by all or a part of the main arrangements hereunder:

1) The sealing ring is provided on the one hand with a front portion which is designed to abut against the face of the nipple and which is of sufficient thickness to be practically undeformable and, on the other hand, with a substantially frusto-conical rear portion of relatively small thickness and consequently deformable which extends from the periphery of the front portion and which is provided internally in the vicinity of its rear extremity with a sharp annular edge formed internally:

2) The clamping nut is provided internally with a substantially conical portion which corresponds to the conical portion of the ring and the summit angle of which is slightly greater than that of this latter;

3) Prior to clamping in position, the rear portion of the ring is in contact at the extreme rear edge thereof with the corresponding conical portion of the clamping nut;

4) There is formed within the ring between the deformable rear portion thereof and the tube a cavity or channel having, for

example, a trapezoidal shape so that as a result of clamping of the nut, the conical portion of this latter contacts said deformable portion until their surfaces coincide, with concomitant penetration of the sharp edge in the outer wall of the tube, a small number of leakage channels of calibrated depth are cut in the sharp circular edge of the sealing ring, said calibrated depth being so determined that the mechanical resistance to disengagement of the connected tube is at least equal to a known value, said depth being additionally intended to correspond approximately to one half the normal depth to which the sharp circular edge is embedded in the wall of the tube including the beading which is formed.

The result produced by the clamping of the nut against the nipple is under these conditions as follows:

a) the clamping nut is brought towards the front face of the nipple in a movement which results in the deformation of the rear conical portion of the sealing ring and causes this latter to pivot substantially about the large base thereof, that is to say about its point of junction with the front portion of said ring, the result achieved by said deformation being to cause the two conical surfaces of the sealing ring and of the clamping nut to be applied perfectly against each other whilst the sharp edge penetrates in the outer wall of the tube to be connected. From this moment, no further deformation of the sealing ring is possible and the pressure which results from the clamping action of the nut is transmitted to the face of the nipple by the undeformable thick portion of the ring, thereby giving the operator the absolutely unmistakable perception of metal to metal clamping which indicates the final and correct assembly of the connector;

b) the forward displacement of the sharp circular edge of the sealing ring is produced at the same time as a reduction in the diameter thereof or in other words, the cutting portion of said sharp circular edge is caused to penetrate progressively and at an oblique angle into the outer wall of the tube or pipe to be connected so as to force back in said wall a circular bead which will be leak-tight only when the depth of penetration of said sharp edge is greater than the calibrated depth of the leakage channels formed at the periphery thereof.

In order that the character of the present invention may be more clearly set forth and in order to highlight the essential forms of the present device, a certain number of examples of embodiment of the present invention will now be described hereinafter, reference being made to the accompanying drawings, in which:

— Figure 1 is a partial view in sectional elevation of a connector in accordance with the invention. The connector is fitted in position on the tube to be connected but has not been clamped thereon;

— Fig. 2 is an external view in the direction *f* of the sealing ring of the connector which is shown in Fig. 1;

— Fig. 3 is a diagrammatic view of the path followed by the cutting portion of the sharp circular edge of the sealing ring at the time of clamping of a connector in accordance with the invention;

— Fig. 4 is a partial view in sectional elevation of the connector which is shown in Fig. 1, after the coupling operation has been completed;

— Fig. 5 is a partial view in sectional elevation of a second type of connector in accordance with the invention. The connector is placed in position over the tube to be connected but has not been clamped in position;

— Fig. 6 is a partial view in sectional elevation of a third type of connector in accordance with the invention. The connector is placed in position on the tube to be connected but has not been clamped in position.

Fig. 1 relates to a first form of embodiment of a connector in accordance with the invention. Said connector which, as shown in the figure, has not been inset, is composed of a nipple 44, a sealing ring 45 formed of material which is generally harder or which has a harder surface than that of the tube 46 in order that said ring can be inset in this latter, and a clamping nut 47.

The nipple is shown only in a partial sectional view of one end thereof. Said end is threaded at 48 and terminates in a bearing and sealing face 49 which is at right angles to its axis, that is to say to the coupling axis. A cylindrical bore 50, the diameter of which is equal to the internal diameter of the tube to be connected, has its opening on said face and puts this latter in communication with the interior of the nipple.

The clamping nut 47 is screwed onto the threaded portion 48 of the nipple and imprisons the sealing ring 45 between the bearing face 49 and its own rear portion 51.

Before being subjected to any deformation, the sealing ring 45 has a front face 52 which is machined at right angles to its axis —and therefore to the coupling axis—and which is intended to be applied exactly against the bearing and sealing face 49 which is in oppositely facing relation thereto.

The cylindrical bore 53 of the ring 45 opens onto said front face 52 and has a diameter which is equal to the internal diameter of the tube to be connected. Said bore extends towards the rear in the form

of a second concentric bore 54 having a diameter which is slightly greater than the maximum external diameter of the tube to be connected so as to form a notch 55 against which the front face of the tube is abuttingly applied. By virtue of this particular arrangement, the sealing ring 45 is of so-called "oriented" design since the operator cannot do otherwise than to position it correctly over the tube to be connected.

Considered from the front to the rear, the sealing ring consists of two distinct portions, namely the front portion 56 of relatively substantial thickness and practically undeformable and the rear portion 57 which is both thin and deformable. Externally, the thick portion 56 of the sealing ring whose front face 52 is in contact with the nipple is of cylindrical shape and the diameter of said front portion is slightly smaller than the diameter of its housing, said housing being constituted, for example, by the threaded portion 48. Said cylindrical portion 58 extends towards the rear over a suitable length which is a function of the external diameter of the tube to be connected. An external hollowed-out portion 59 of small size and in the shape of an annular depression provides the means whereby the thick front portion 56 is joined to the thin and deformable rear portion 57 of the sealing ring. Externally, the said rear portion has the shape of a cone having a half-angle at the vertex of approximately 20° to 35°. The generator-line of said conical surface 60 starts from the rear portion of the external annular depression 59 and gradually slopes down towards the external surface of the tube 46 until it encounters the conical bore 61 providing internal clearance and formed at the rear of the sealing ring.

The two above-mentioned conical surfaces 60 and 61 are joined to each other by a slight chamfer 62 which constitutes the rear extremity of the sealing ring.

After having been bored at 54 so as to accommodate the tube 46 to be connected, the said sealing ring is hollowed-out internally so as to form a channel 63 of suitable profile for the purpose of thinning-down the rear portion 57 and in order to make this latter both flexible and deformable. The front extremity of said channel 63 extends into the bore 54 approximately at the level of the end of the external cylindrical portion 58. Said front extremity has in this example a trapezoidal shape, the large base of the trapezium being formed by the generator-line of the cylindrical bore 54, the opposite side being formed by the generator-line 64 of a conical surface which is substantially parallel to the external conical surface 60 of the sealing ring. The space component between the generator-lines 60 and 64 of these two conical surfaces constitutes the thickness of the thin and deformable rear portion 57 of the sealing ring. Said thickness is dependent on the external diameter and on the nature of the metal of the tube to be connected. Said rear portion must be sufficiently thin to permit this latter to be readily deformed at the time of assembly of the connector and yet of sufficient thickness to withstand the reaction of the tube to the effort of penetration of said sealing ring in the outer wall thereof at the time of the insetting operation.

The two other sides of the trapezium constitute the front lateral face 65 and rear lateral face 66 of the channel 63. The front face 65 is inclined to the rear of the connector in such a manner as to facilitate the machining of said channel whereas the rear face 66 is inclined to the front for the same reason and also because its intersection with the bore 54 constitutes the sharp circular edge 67 which is intended to be embedded in the outer wall of the tube at the time of assembly of the connector (as shown in Fig. 1).

The inclination of the rear face 66 towards the front end prior to any deformation process as shown in Fig. 1 is such that, after insetting as shown in Figs. 3 and 4, said rear face is still inclined in the same direction, the final angle of inclination being preferably between 0 and 10° relatively to the line at right angles to the axis of the tube to be connected.

In order to facilitate the penetration of the sharp circular edge 67 in the outer wall of the tube 46, this latter is relieved at the rear by means of a conical bore 61 having a suitable summit angle and the flared extremity of which is joined to the conical surface 60 by means of a slight chamfer 62. The conicity of the bore 61 must be such as to cause no interference with the penetration of the sharp circular edge but to fit exactly within the channel formed by said edge in the tube to be connected at the time of assembly of the connector (as shown in Fig. 3).

A certain small number of leakage grooves 68 are cut in the periphery of the sharp circular edge 67 and the perfectly calibrated depth (p) of said grooves exactly corresponds to the minimum depth to which said sharp edge is intended to be embedded in the outer wall of the tube 46 at the time of assembly of the connector so that this coupling between the sealing ring and the tube should have a minimum predetermined mechanical strength.

Fig. 2 which represents the rear view (in the direction of the arrow *f* of Fig. 1) of the sealing ring 45 shows the arrangement of the leakage grooves 68. In this form of embodiment which is given solely by way

of example, provision is made for four leakage grooves 68 uniformly spaced apart over the periphery of the sharp edge 67.

The number of said leakage grooves, the shape of which is of practically no importance, must not be great. Certain known embodiments have provided the sharp circular edge with veritable pointed teeth for the purpose of facilitating at the outset the penetration of the sharp edge in the wall of the tube 46 in such a manner as to enable the operator to detect the completion of the insetting operation, the clamping couple being intended to increase rapidly with the penetration of the teeth in the tube to be connected. Aside from the fact that the depth of the teeth is not intended to endow the assembled connector with a minimum degree of mechanical strength, this set of teeth is subject to the disadvantage which lies in its basic design. While the ring can thus be more readily inserted in the tube, said ring can also be more readily ejected from the tube at the time of coupling inasmuch as each tooth in fact constitutes a veritable cutting tool having a more or less sharp cutting edge. Moreover, since said set of teeth easily penetrates at the time of initial insetting in the tube 46, the sharp edge is thereby prevented from restoring to a suitable circular profile the tubes which are available in commerce and which are nearly always ovalized. For this reason, certain teeth are fully embedded in the wall of the tube to be connected while others are not thus fully embedded. It is extremely difficult to obtain the complete penetration of all of these teeth unless recourse is had to over-tightening of the connector which is wholly detrimental to its properties and to its length of service. The number of leakage grooves according to the present invention is obviously dependent on the diameter of the tube. Excellent results have been achieved in practical tests in which the numbers of uniformly spaced leakage grooves provided ranged between 3 and 8.

The external conical surface 60 of the sealing ring is in contact at the end corresponding to its shortest diameter with the internal and conical surface 69 of the rear portion 51 of the clamping nut 47.

The said conical surface 69 has a summit angle which is distinctly more obtuse than the summit angle of the conical surface 60 of the sealing ring. This half-angle at the summit or vertex can vary between 30° and 50°. The largest diameter of said conical surface 69 is slightly greater than the largest diameter of the conical surface 60 of the sealing ring.

The assembly of the connector is carried out in the following manner: in the initial position, the different parts of the connector are placed as shown in Fig. 1, the front face of the tube 46 to be connected being in abutment with the base 55 of the bore 54 of the sealing ring. The operator accordingly tightens up the nut 47 with a suitable spanner until he feels very distinctly a metal to metal clamping action. At this moment, the assembly is completed and the component parts of the connector are located in the positions shown in Fig. 4.

The coupling process is as follows:

At the time of clamping of the nut 47, the rear conical surface 60 of the sealing ring 45 which is in contact at the small-diameter end thereof with the internal conical surface 69 of the clamping nut is driven forward and subjected to deformation. This deformation results in a pivotal movement of the flexible and deformable rear portion 57 of the sealing ring, the centre of said pivotal movement being located substantially at the intersection of the generator-line of the rear conical surface 60 of the sealing ring with the generator-line of the external annular recess 59 at which the front portion 58 of the ring is joined to its rear portion 57. It is possible to follow this movement by reference to Fig. 3. At a certain moment during the tightening-up process and resulting deformation of the flexible and deformable rear portion 57, the sharp circular edge 67 comes into contact at (m) (as shown in Fig. 3) with the tube to be connected.

Starting from this point, the continued tightening-up of the nut causes the penetration of the sharp edge 67 along the line $x—x^1$ into the outer wall of the tube 46. Since the tube is in position of abutment and cannot follow the forward motion of the sharp circular edge 67, said edge, at the same time as it penetrates into said outer wall, drives back the material which constitutes the tube 46, thus forming a veritable beading 70. This motion continues until the two conical surfaces, namely the conical surface 69 of the clamping nut and the conical surface 60 of the sealing ring are perfectly applied one against the other as shown in Fig. 4 and until the internal conical face 69 of the nut comes into contact through the rear extremity of the external annular recess 59 with the thick and undeformable portion 56 of the sealing ring. From this moment, and by reason of the very presence of said thick and undeformable portion, the operator immediately feels the locking of metal against metal and the assembly of the connector is completed (as shown in Fig. 4).

The dimensions of the component parts must be such that, after assembly, the bottom of each leakage groove 68 usually reaches approximately one half the height including the beading, of the front face of the groove which is formed by the sharp

edge 67 at the time of assembly of the connector and of its penetration in the tube 46. The external annular recess or depression 59 of the sealing ring must permit the possibility of taking up the slight diametral deformation which results both from the pivotal motion of the rear portion 57 of the ring and from a slight increase in the maximum diameter thereof which is brought about by the reaction of the tube to the penetration of the sharp circular edge 67 without thereby resulting in any jamming of the sealing ring in the clamping nut 47 at the time of assembly of the connector. The position of said external annular recess 59, the position of the front face 65, the position of the internal channel 63 as well as the length of the radius which joins said front face 65 to the internal conical surface 64 of the channel 63, all permit of ready deformation of the rear portion 57 of the ring and enable the operator who is tightening-up the nut 47 to gain the almost immediate perception of a metal to metal locking action when said nut reaches the position shown in Fig. 4, wherein the internal conical face 69 of the nut is in contact at the large-diameter end thereof and through the intermediary of the external annular recess 59 with the thick and practically undeformable front portion 56 of the sealing ring.

In a second form of embodiment in accordance with the invention which is illustrated in Fig. 5, the internal face 72 of the clamping nut 47 no longer has a rectilineal generator-line but a curvilineal generator-lin 73 in such a manner as to obtain a convex surface which has the intended effect of increasing the tightening travel of the nut and of accentuating the feeling of metal to metal contact when the connector is assembled. In fact, the contact of the nut 47 with the thick and undeformable front portion 56 of the sealing ring is carried out at an angle which is appreciably smaller than in the previous form of embodiment.

In a third form of embodiment also in accordance with the invention as illustrated in Fig. 6, the internal face 74 of the clamping nut 47 is conical as in the first form of embodiment but the flexible and deformable rear portion 75 of the sealing ring is convex, the result thereby achieved in respect of an identical length of travel of the clamping nut being to increase the penetration of the sharp circular edge 67 into the outer wall of the tube to be connected. Furthermore, the front face 76 of the sealing ring which is applied against the plane face 49 of the nipple has a convex profile, with the result that the space 77 which progressively increases towards the exterior of the connector is capable of absorbing the very slight axial deformation of said sealing ring under the action of a powerful clamping of the connector at the time of assembly of this latter.

It can readily be understood that a connector in accordance with the invention provides the following features at the same time:

1) The transverse assembly of tubes or pipes to be coupled together and the transverse disassembly of tubes or pipes already coupled together. Leak-tightness is achieved between the ring 45 which is fixed on the tube and the nipple as a result of contact and pressure but without taking into account the two plane faces 49 and 52 (as shown in Figs. 1 and 4) which are perpendicular to the axis of the tube and to the direction of coupling; it is therefore merely necessary to disengage the clamping nut 47 from the nipple and to withdraw it to the rear so as to permit the possibility of withdrawing the tube (or of placing this latter in position) as a result of a simple translational movement of said tube at right angles to its axis.

2) The elimination of any possibility of error in the possible orientation of the sealing ring on the tube to be connected. In fact, if the sealing ring is mounted back to front in the connector, it is strictly impossible to introduce the tube within the ring. Insetting of the ring on the tube therefore cannot take place and this latter does not remain in position within the interior of the connector even as a result of simple pressure or friction, such a condition being immediately perceptible by even the most inexperienced operator and radically eliminates any likelihood of accidents occurring as a result of disengagement under pressure of a tube to be connected.

The same would apply if the operator were to attempt another method of assembly and were to set in position on the tube 46 first the clamping nut 47 and then the sealing ring 45 prior to fitting the assembly against the nipple 44. It will only be possible to place the sealing ring over the tube in the proper direction and will prove absolutely impossible to fit it in position in the opposite direction.

3) As soon as the correct insetting of the sealing ring on the tube to be connected has been completed, the operator is given a distinct and easily recognisable indication of the locking of metal against metal; the locking referred-to is that of the internal face 69 of the clamping nut 47 against the front portion 56 of the thick and practically undeformable sealing ring; at this moment, the flexible and deformable rear portion 57 no longer plays any part insofar as concerns the

value and variation of this locking couple.

4) It is made possible by means of the leakage grooves 68 of calibrated depth to effect the checking, in an easy, reliable and accurate manner, of the uniformity and minimum depth to which the sharp circular edge 67 is embedded in the outer wall of the tube to be connected. The maintaining of said tube within the connector is naturally dependent on this embedding, that is to say on the depth and uniformity thereof. In the case in which this depth were not sufficient or irregular, the mechanical strength of the coupling would be substantially reduced, with the result that the tube would be liable to separate from the connector at pressures which may be of a high order but substantially lower than those which would be maintained by correct insetting of the sealing ring. A large number of practical experiments have demonstrated the fact that such variations, which are undetectable or which in any case cannot be measured in coupling systems of the prior art, are responsible for the extremely serious accidents which arise from the ejection of tubes from their connectors under the action of the pressure of fluids conveyed therein.

In the connectors in accordance with the invention, the provision of calibrated leakage grooves which are small in number but uniformly spaced along the sharp circular edge 67 will have the effect of permitting leakage towards the rear of the connector, that is to say between the tube 46 and the clamping nut 47 as long as they are not all embedded to a depth which is at least equal to their own depth in the outer wall of the tube to be connected. By virtue of this particular feature, it will merely be necessary, for example, to subject the assembled connector or connectors to a low pressure of air and to check for leakage to the rear of said connectors between the nuts and the tubes. All connectors which are fitted with correctly inset rings will not give rise to any leakage and will accordingly make it possible to ensure with every degree of certainty that the mechanical strength specified by the manufacturer is attained without difficulty. On the other hand, all connectors in which leakage is revealed will indicate defective insetting and must accordingly be checked (insufficient tightening, defective sealing ring, tube not within permissible tolerances, highly ovalized, scored or of irregular shape) and replaced if necessary.

5) The connector can be employed at very high pressure inasmuch as the only delicate element of said connector is the flexible and deformable rear portion 57 of the sealing ring, but when this portion is assembled, it is wholly and reliably supported by the internal face 69 of the clamping nut 47. Even very high pressures of fluid which is conveyed through the piping system are therefore in no way liable to deform or damage the connector.

6) Pipe-connections can be obtained by means of rings which are pre-inset in the tubes to be coupled and have a degree of leak-tightness and useful life which are as good as if the connectors had been mounted directly on the nipples against which they will finally be placed in position.

In fact, leak-tightness between the ring and the tube or pipe to be connected depends only on these two elements, and is therefore wholly independent of the nipple and consequently of its dimensional tolerances. Similarly, since leak-tightness between the rings and the nipple is ensured by contact and pressure of two plane faces, namely the faces 49 and 52 which are perpendicular to the axis of the tube and of the coupling, it is also completely independent of all the dimensional tolerances of the components employed and of the tube or pipe to be connected.

This particular feature also makes it possible:

—to provide absolute interchangeability of all connectors of the same size and type without any danger of reduction of leak-tightness and mechanical strength of such connectors.

—to readily permit of pre-insetting of the sealing ring in a tube which has previously been provided with a channel corresponding very substantially to that which would have been formed by the sharp circular edge 67 as a result of the direct insetting thereof.

This mode of procedure is advantageous and even essential:

—in the case of tubes having large diameters since the self-insetting efforts of the sealing ring in fact increase with the dimensions of the tubes to be coupled and rapidly become considerable if not impossible to apply in situ;

—when providing pipe-connections having particular characteristics as regards the homogeneous character of the materials employed, in the event that the material of the sealing ring depends on the material of the tube to be connected and does not lend itself for this reason to a suitable heat treatment of surface hardening (stainless steel, nickel, monel metal, titanium, etc.)

In fact a previously formed groove is easy to localize in an accurate manner with respect to the front face of the tube to be connected, and the method of machining employed makes it possible in an elementary manner to eliminate radically the wholly unfavourable influence of the substantial dimensional tolerances which exist on the ex-

ternal diameters of tubes to be connected. It is merely necessary in order to achieve this result to ensure that the tool which is employed for the purpose of forming the preliminary groove cuts the tube along the path x—x¹ (shown in Fig. 3) which would be followed by the sharp circular edge 67 at the time of direct insetting. When this important cause of interference has been removed, the secondary causes of interference, namely, the variations existing in the diameter of the sharp circular edge 67, the position of said edge relatively to the base 55 of the bore 54 and the conicity of the internal face 69 of the clamping nut 47 are extremely easy to reduce to a negligible value since these elements can all be produced by means of shaped tools and accurately checked.

Under these conditions, it is possible to carry out with certainty the precise introduction of the sharp circular edge 67 within the groove which has previously been formed in the tube to be connected and a slight tightening of the nut 47 will give to the surfaces which are already in contact the pressure which is essential to the provision of the desired leak-tightness.

It can readily be understood that, by virtue of the judicious cooperation of the shape and dimensions of the sealing ring and especially of the front portion thereof, —of the conicity of the rear portion thereof;

—of the conicity of the corresponding bearing face of the clamping element,

—and of the depth of the leakage grooves, it is possible to provide a connector which will at the same time:

—Permit the transverse assembly of tubes or pipes to be coupled and the transverse disassembly of tubes or pipes to be coupled—

—Make it impossible for an operator to commit any error in possible orientation of the sealing ring on the tube or pipe to be connected—

—Provide the operator with a distinct and easily recognisable indication of a locking of metal against metal as soon as the insetting of the sealing ring on the tube or pipe to be connected has been completed—

—Provide by virtue of the leakage grooves an easy and accurate means of checking the minimum depth to which the sealing ring is embedded in the outer wall of the tube to be connected, this arrangement being intended to prevent any accident by means of a simple leak-tightness check inasmuch as any connector in which leakage is observed will accordingly be insufficiently clamped and dangerous—

—Permit of use at very high pressures inasmuch as the only delicate portion of the connector is the flexible and deformable rear portion of the sealing ring and said portion is supported over its entire surface as soon as the coupling is completed by the corresponding conical surface of the clamping element.

—Provide pre-inset connectors having leak-tightness and useful life which are just as good as if they were mounted directly on the nipples against which they will finally be fitted in position; leak-tightness between ring, tube or pipe being strictly independent of the nipple and of its dimensional tolerances and being similarly independent of the leak-tightness established between ring and nipple which is ensured as a result of simple contact under pressure of two faces which are perpendicular to the axis of the tube or pipe and consequently to the direction of clamping motion.

WHAT I CLAIM IS:—

1. Leak-tight connector for coupling a tube to the nipple of a threaded body comprising a deformable ring which is provided internally with a sharp edge adapted to penetrate in the external surface of the tube, and a nut for clamping said ring against said nipple by screwing onto said nipple, wherein the sealing ring comprises in combination, on the one hand, a front portion which is designed to abut against one face of the nipple which is substantially plane and located in a plane at right angles to the axis of the body, said front portion being of sufficiently substantial thickness to be practically undeformable and, on the other hand, a substantially frusto-conical rear portion of relatively small thickness and consequently deformable which extends from the periphery of the front portion and which is provided internally and in the vicinity of its rear extremity with a sharp annular edge formed internally.

2. Leak-tight connector as defined in Claim 1, wherein the clamping nut is provided internally with a substantially conical portion which corresponds to the conical portion of the ring and the summit angle of which is slightly greater than that of said ring.

3. Leak-tight connector as defined in Claim 1 and Claim 2, wherein, prior to clamping in position, the rear portion of the ring is in contact only at the extreme rear edge thereof with the corresponding conical portion of the clamping nut.

4. Leak-tight connector as defined in Claim 1, wherein there is formed within the ring between the deformable rear portion thereof and the tube a cavity or channel having, for example, a trapezoidal shape so

that, as a result of the tightening of the nut, the conical portion of said nut contracts said deformable portion until their surfaces coincide, with concomitant penetration of the sharp edge in the outer wall of the tube.

5. Leak-tight connector as defined in Claim 1, wherein the rear conical portion of the ring preferably makes an angle of 20° to 35° with the axis of the connector and the corresponding internal portion of the clamping nut makes an angle of 30° to 50°. with this same axis.

6. Leak-tight connector as defined in Claim 1 and Claim 4, wherein the rear face of the trapezoidal channel formed in the interior of the sealing ring constitutes the front face of the sharp circular edge and has an initial inclination such that, after insetting in the outer wall of the tube to be connected, said face is inclined towards the front of the connector, the angle of inclination as measured relatively to a line which is perpendicular to the axis of the tube to be connected being comprised between 0° and 10°.

7. Leak-tight connector as defined in Claim 1, wherein the sharp circular edge of the sealing ring is relieved at the rear by means of a conical bore having a conicity such that said conical surface facilitates and does not interfere with the penetration of the sharp circular edge in the outer wall of the tube to be connected but fits exactly within the groove which is thus formed by said circular edge at the time of assembly of the connector.

8. Leak-tight connecteor as defined in Claim 1, characterized in that the flexible and deformable rear portion of the sealing ring is joined to the thick undeformable front portion of said ring by a portion which forms a slight annular depression so as to absorb the slight diametral deformation which is produced at this point as a result of the pivotal motion of the flexible and deformable rear portion and as a result of the reaction of the tube to the penetration of the sharp circular edge in the wall of the tube to be connected at the time of assembly of the connector.

9. Leak-tight connector as defined in Claims 1, 4 and 8, wherein the connecting throat between the front face and the oblique face of the trapezoidal channel is substantially in the same transverse plane as said annular depression according to Claim 8, so as to produce an easy pivotal movement of the flexible and deformable rear portion about its point of junction with said external recess and the rapid locking of metal against metal at the time of contact of the conical bearing surface of the clamping element with the base of this same external recess.

10. Leak-tight connector as defined in Claim 1 or Claim 2, wherein the largest diameter of the conical bearing surface of the clamping element is greater than the largest diameter of the flexible and deformable rear portion of the sealing ring in such manner as to ensure that, when the assembly of the connector is completed, said sealing ring is supported over its entire length by said conical bearing surface of the clamping element in such a manner as to prevent said surface from being subjected to the effects of the pressure of the fluid conveyed within the piping system.

11. Leak-tight connector as defined in Claim 1 and Claim 2, wherein a small number of leakage channels of calibrated depth are cut in the sharp circular edge of the sealing ring, said calibrated depth being so determined that the mechanical resistance to disengagement of the connected tube is at last equal to a known value.

12. A modification of the leak-tight connector as defined in Claim 1 and Claim 2, wherein the conical bearing surface of the clamping element does not have a rectilineal generator-line but a curvilineal generator-line in such a manner as to give it a convex shape.

13. A modification of the leak-tight connector as defined in Claim 1 and Claim 2, wherein the external conical surface of the flexible and deformable rear portion of the sealing ring does not have a rectilinear generator-line but a curvilinear generator-line in such a manner as to give it a convex shape.

14. A modification of the leak-tight connector as defined in any one of Claims 1 to 13, wherein the front face of the sealing ring which is applied against the plane rear face of the nipple has a convex profile in such a manner that the progressively increasing clearance towards the exterior which initially exists between said two surfaces is capable of absorbing the very slight axial deformation of said ring under the action of a powerful clamping of the connector at the time of assembly.

15. A connector substantially as described with reference to Figures 1—4, 5 or 6 of the accompanying drawings.

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from which copies may be obtained.

Fig: 1

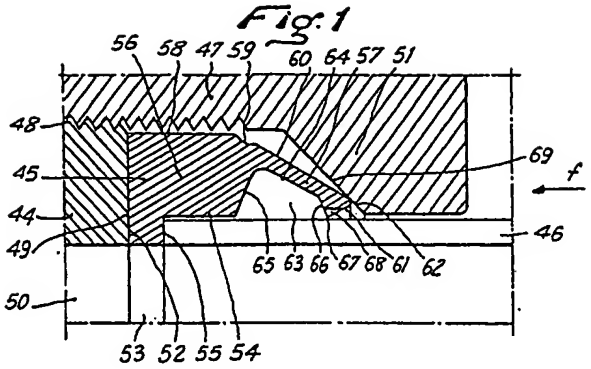


Fig: 2

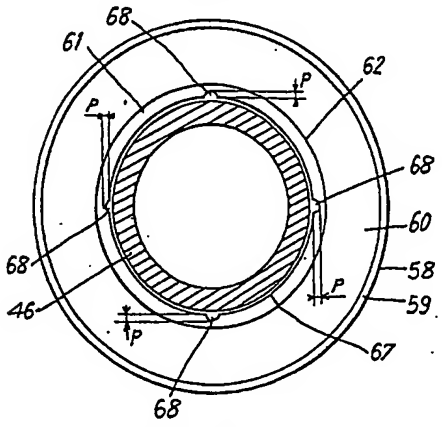
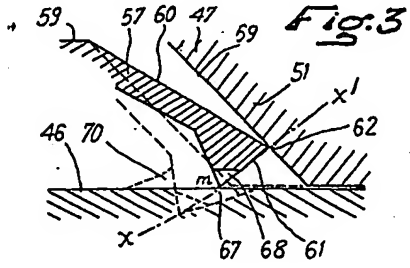


Fig: 3



1057900 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

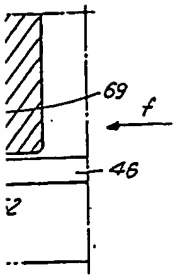


Fig: 4

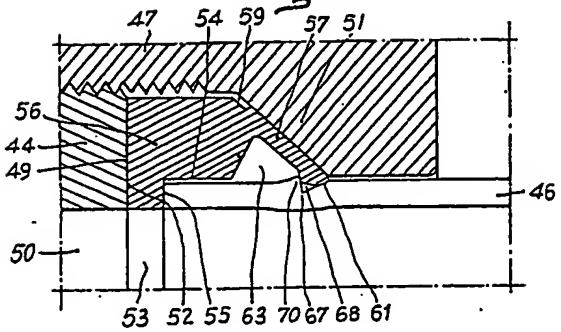
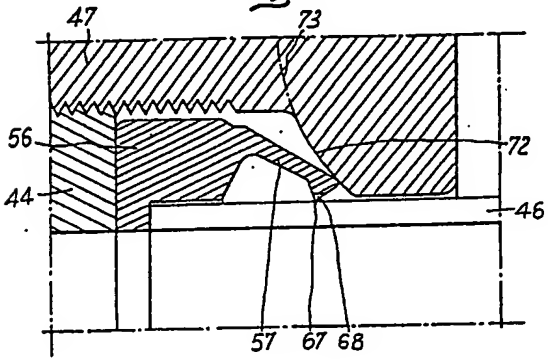


Fig: 5



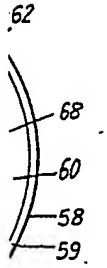
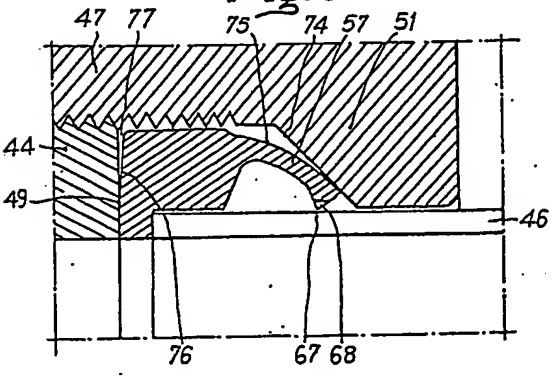
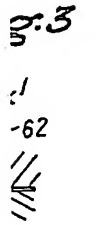


Fig: 6





1057900 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

Fig: 1

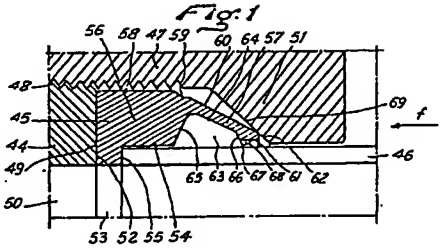


Fig: 2

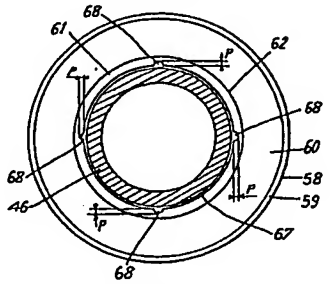


Fig: 3

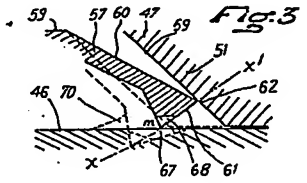


Fig: 4

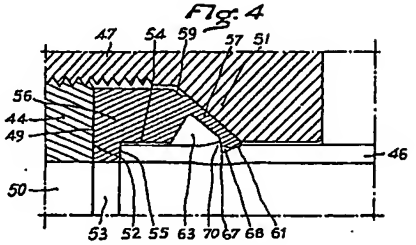


Fig: 5

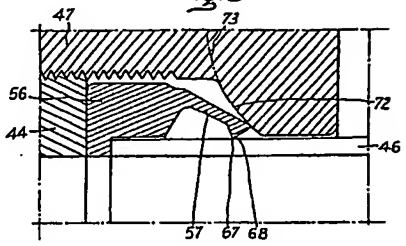


Fig: 6